Special Flood Hazard Evaluation Report

Tonawanda Creek

Village of Attica, Wyoming County, New York

Prepared for the
New York State Department of Environmental Conservation

US Army Corps
of Engineers
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This report presents local flood hazard information for Tonawanda Creek in the Village of Attica, New York. The U.S. Army Corps of Engineers, Buffalo District will provide interpretation in the application of the data contained in this report, particularly as to its use in developing effective flood plain regulations.

Changes in hydrology and hydraulics reflected in this study are the results of a more detailed analysis, primarily new procedures and additional flow data, of Tonawanda Creek. This is particularly true for the reach downstream of the guage station. The Prospect Road vicinity was more accurately modeled in this study. Additionaly, flows introduced by Tunnery Brook were accounted for in the current study.

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SPECIAL FLOOD HAZARD EVALUATION REPORT
TONAWANDA CREEK
VILLAGE OF ATTICA, WYOMING COUNTY, NY

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INTRODUCTION

This Special Flood Hazard Evaluation Report documents the results of an investigation to determine the potential flood situation along Tonawanda Creek within the Village of Attica, Wyoming County, New York. This study was conducted at the request of the New York State Department of Environmental Conservation under the authority of Section 206 of the 1960 Flood Control Act, as amended. The study reach includes Tonawanda Creek from the northeastern corporate boundary, upstream to the southern corporate boundary.

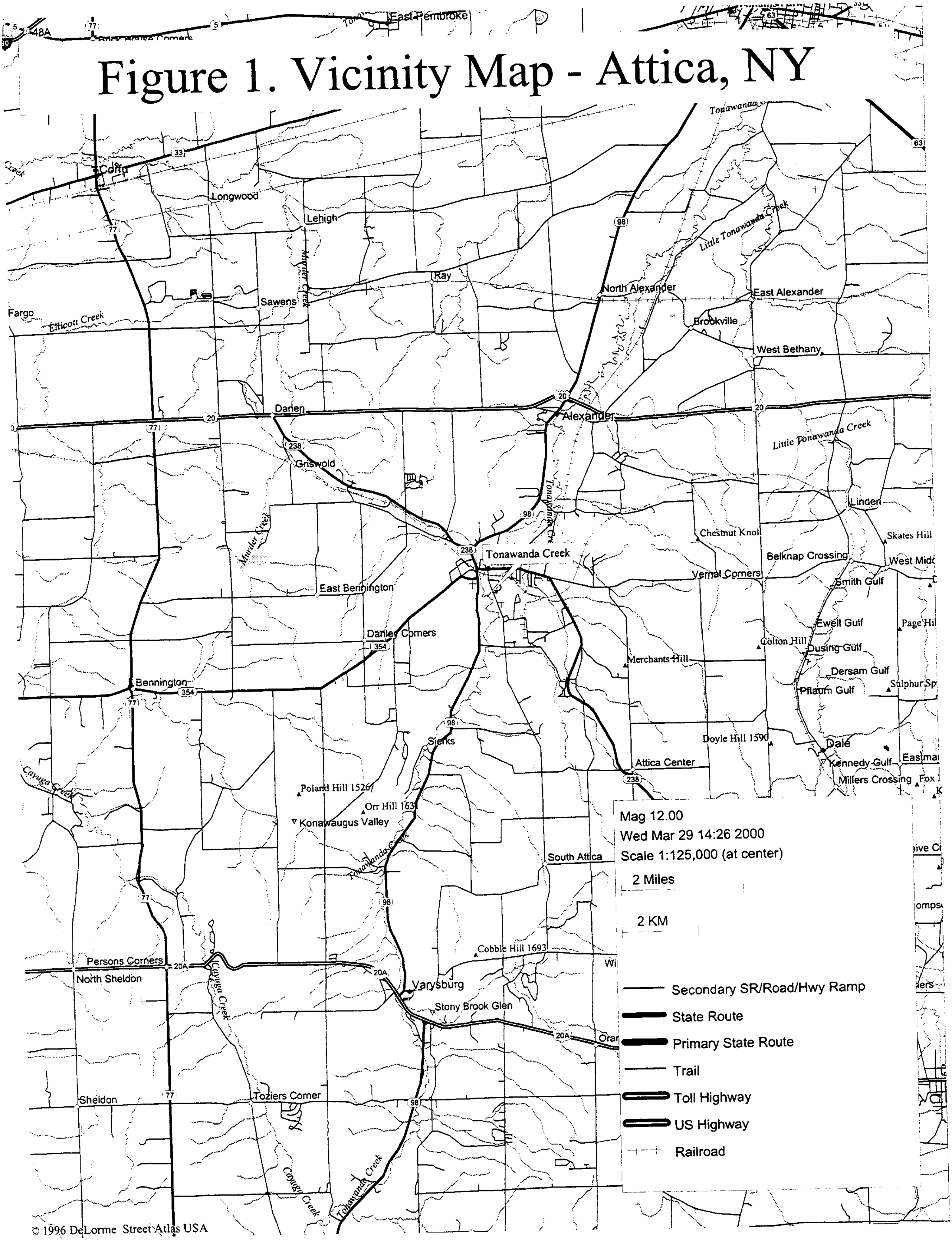
The Village of Attica is located in northwest Wyoming County and is partially located in Genesee County, approximately 31 miles east of Buffalo and 48 miles southwest of Rochester, NY. The Village of Attica is completely contained by the Town of Attica, except for the small portion located in Genesee County. The Town of Alexander borders the area located in Genesee County. The Village of Attica population is 2,622 in Wyoming County and 8 in Genesee County according to the 1990 census (Reference 1). Tonawanda Creek originates in the Town of Java and flows in a northerly direction through the Village of Attica before turning west and flowing into the Niagara River.

Knowledge of potential floods and flood hazards is important in land use planning. This report identifies the 1 percent (100-year) and 0.2 percent (500-year) flood plains for the reaches studied.

Information developed for this study will be used by local officials to manage future flood plain development. While the report does not provide solutions to flood problems, it does furnish a suitable basis for the adoption of land use controls to guide flood plain development, thereby preventing intensification of the flood loss problem. It will also aid in the development of other flood damage reduction techniques to modify flooding and reduce flood damages which might be embodied in an overall Flood Plain Management (FPM) program. Other types of studies, such as those of environmental attributes and the current and future land use roles of the flood plain as part of its surroundings, would also profit from this information.

Although Flood Insurance Rate Maps have been developed for the community, recent flooding events indicate that changes may have occurred which affect the flood plain. Extensive flooding occurred in the Village in 1997 and 1998. The July 8,1998 flood event claimed two lives and caused significant damage to the Village Wastewater Treatment Plant which is located just downstream of Prospect Street. Highwater marks taken by the Village during the flood exceeded 1 percent flood elevations shown on the 1986 FIRM (Reference 2). Additional information received from the New York State Department of Transportation (NYSDOT) during the design of a new bridge at Prospect Street indicated 1986 floodplain maps did not accurately depict actual flood conditions. 1 percent flood elevations calculated by the NYSDOT were 1.5 feet higher than those shown on the existing FIRM. Discharge-frequency relationships determined in this study indicate that the flooding event of July 8, 1998 approximates a 0.5 percent flood event. Currently, the Village Wastewater Treatment Plant is operating under a consent order

Figure 1. Vicinity Map - Attica, NY



by the New York Department of Environmental Conservation (NYSDEC). Accurate data is required to determine the level of protection required for the treatment plant. In addition the Village needs accurate information to successfully manage floodplain development.

Additional copies of this report can be obtained from the NYSDEC until its supply is exhausted, and the National Technical Information Service of the U.S. Department of Commerce, Springfield, Virginia 22161, at the cost of reproducing the report. The Buffalo District Corps of Engineers will provide technical assistance and guidance to planning agencies in the interpretation and use of the hydrologic data obtained for this study.

PRINCIPAL FLOOD PROBLEMS

Although flooding may occur during any season, the principal flood problems have occurred during winter and spring months and are usually the result of spring rains and or snowmelt.

Flood Magnitudes and Their Frequencies

Special flood hazard areas are determined with reference to the "100-year" flood standard, which is a national standard on which flood regulations are based. The "100-year" flood, also referred to as a "base flood," is defined as the flood having a 1 percent probability of being equaled or exceeded in any given year. The risk of experiencing a flood of this magnitude increases with the length of time considered. While it represents the long term average recurrence interval for a flood of this magnitude, such floods may be experienced in any given year. There is a greater than 50 percent probability that a "100-year" event will occur during a 70-year life time, and there is a 26 percent (about one in four) probability of experiencing such a flood over a typical 30-year mortgage period. The "100-year" flood is more properly termed the 1 percent chance exceedance flood or "1 percent flood," which represents its true probability of being equaled or exceeded in any year.

Hazards and Damages of Large Floods

The extent of damage caused by any flood depends on the topography of the flooded area, the depth and duration of flooding, the velocity of flow, the rate of rise in water surface elevation, and development of the flood plain. Deep water flowing at a high velocity and carrying floating debris would create conditions hazardous to persons and vehicles which attempt to cross the flood plain. Generally, water 3 or more feet deep which flows at a velocity of 3 or more feet per second could easily sweep an adult off his feet and create definite danger of injury or drowning. Rapidly rising and swiftly flowing floodwater may trap persons in homes that are ultimately destroyed or in vehicles that are ultimately submerged or floated. Since water lines can be ruptured by deposits of debris and by the force of flood waters, there is the possibility of contaminated domestic water supplies. Damaged sanitary sewer lines and sewage treatment plants could result in the pollution of floodwaters and could create health hazards. Isolation of areas by floodwater could create hazards in terms of medical, fire, or law enforcement emergencies.

HYDROLOGIC ANALYSES

A hydrologic analysis was carried out to determine the peak discharge-frequency relationships for the flooding sources affecting the community. A discharge-frequency relationship for the stream gage on Tonawanda Creek (#04216418) was calculated using guidelines established in Bulletin 17b from the Department of the Interior (Reference 3) and the Corps Hydrologic Engineering Center's Flood Flow Frequency program (Reference 4). Because the confluence of Tannery Brook and Tonawanda Creek is within the study boundaries, two hydrologic regions were delineated. Reach #1 is from the downstream study limit to just downstream of Tannery Brook, and Reach #2 is from just upstream of Tannery Brook to the upstream study limit. The discharge-frequency relationship calculated at the gage was used for Reach #2. Flows introduced by Tannery Brook were determined by regionalization regression equations developed by the United States Geological Survey (USGS) (Reference 5) and were used to produce discharges for Reach #1. Discharges for the 1 percent and 0.2 percent floods were analyzed for this study. The 0.2 percent flood (500-year) peak discharge was extrapolated from the discharge frequency relationship developed using annual peak discharges of the 50 percent (2-year), 20 percent (5-year), 10 percent (10-year), 4 percent (25-year), 2 percent (50-year), and 1 percent (100-year) floods. Table 1 summarizes the peak discharges for Tonawanda Creek. A summary of hydrology is included as Appendix A.

TABLE 1
SUMMARY OF DISCHARGE

Flooding Source and Location	Drainage Area (sq mi)	10 percent flood (cfs)	Peak Discharges 1 percent flood (cfs)	0.2 percent flood (cfs)
Tonawanda Creek				
At U.S. Geological Gage (USGS) gage #04216418	77.1	5,020	8,520	11,600
Just downstream of confluence with Tannery Brook	82.2	5,490	9,280	12,540

A comparison of discharges at the gage (#04216418) from this study to those of the previous Flood Insurance Study (FIS) indicate a 1,580 cfs drop in the 1 percent flood and 900 cfs drop in the 0.2 percent flood discharges. These changes can largely be attributed to changes in methodology and the availability of 21 years of record for the gauge station at the time of this study.

HYDRAULIC ANALYSES

Analyses of the hydraulic characteristics of flooding from sources studied were carried out to provide estimates of the elevations of floods for the 10 percent, 2 percent, 1 percent and 0.2 percent floods.

Cross-section data for the backwater analyses of Tonawanda Creek were obtained from field surveys performed by Buffalo District personnel. Additional data were obtained from topographic maps (Reference 6) and from the USGS Digital Elevation Model (Reference 7). All bridges and hydraulic structures were surveyed to determine elevation data and structural geometry. Spot elevations were obtained in the overbank areas in order to accurately delineate the floodplain boundaries.

Water surface elevations of the 1 percent and 0.2 percent flood events were computed using the COE HEC-RAS step-backwater computer program (Reference 8). The "Normal Depth" function in HEC-RAS was used to determine starting water surface elevations for Tonawanda Creek; the model was calibrated using high water mark measurements obtained during 1998 flood event. Locations of the selected cross-sections used in the hydraulic analyses are shown on the Flood Profile (Plate 1) and on the Flooded Areas Map, which accompany this report.

Channel and overbank roughness factors (Manning's "n") used in the hydraulic computations were selected using engineering judgement and were based on field observations of the stream and flood plain areas. The values for Manning's "n" and the contraction and expansion coefficients are shown in Table 2.

TABLE 2
MANNING'S "N" AND CONTRACTION & EXPANSION COEFFICIENTS

Flooding Source	Channel	Overbank	Contraction	Expansion
Tonawanda Creek	0.025-0.045	0.08-0.15	0.1-0.3	0.3-0.5

Flood profiles were drawn showing the computed water surface elevations for the selected recurrence intervals. The flood plain boundaries were delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using the topographic maps and spot elevations obtained during field inspection. Small areas within the flood plain boundaries may be above the flood elevations, but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

Floodways were determined for portions of Tonawanda Creek studied in detail. Floodway encroachments were based on equal conveyance reduction from each side of the flood plain, with adjustments as necessary to provide functional and manageable floodways. At the request of the NYSDEC, the maximum increase in stage due to encroachment was limited to 1 foot, provided that hazardous velocities were not produced. Floodway widths were computed at cross sections for Tonawanda Creek. Between cross sections, the floodway boundaries were interpolated. The results of the floodway calculations are summarized for selected cross sections in Table 3.

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the profile are considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

A comparison of the new flood study with the current FIRM indicates an increase in flood elevations for the Prospect Road vicinity. The flood elevations concur within 0.1 feet of those reported for the upstream and downstream limits for the 1 percent flood in the 1986 Village of Attica FIS. The water surface elevations at the downstream limits are also within 0.5 feet of those reported for this station in the Town of Alexander FIS.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Descriptions of the marks are presented in Table 4.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (FEET^2)	MEAN VELOCITY (FEET/SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
A	659	137	1236	7.5	956.2	956.2	957.2	1.0
B	1398	310	3201	2.9	958.5	958.5	959.2	0.7
C	1565	238	1839	5.0	959.3	959.3	960.3	1.0
D	3475	395	2752	3.4	961.4	961.4	962.2	0.8
E	4246	200	1266	7.3	961.0	961.0	961.7	0.7
F	5089	104	909	10.2	962.8	962.8	963.7	0.9
G	5463	78	947	9.8	967.1	967.1	967.1	0.0
H	7262	280	2310	4.0	973.0	973.0	973.1	0.1
I	8913	140	1418	6.5	973.7	973.7	974.0	0.3
J	9922	300	3891	2.4	975.2	975.2	976.2	1.0
K	10720	250	3220	2.7	975.3	975.3	976.3	1.0

[1] FEET ABOVE CORPORATE LIMITS

VILLAGE OF ATTICA, NEW YORK	FLOODWAY DATA
	TONAWANDA CREEK — TABLE 3

TABLE 4
ELEVATION REFERENCE MARKS

Reference Mark	Elevation	Description
RM-1	969.63	Chiseled square on top of the east abutment of Main Street Bridge, upstream side.
RM-2	964.11	Bronze standard gauging station reference mark tablet in upstream corner of gage house pad along right bank of Tonawanda Creek, downstream of Main Street.

UNIFIED FLOOD PLAIN MANAGEMENT

Historically, the alleviation of flood damage has been accomplished almost exclusively by the construction of protective works such as reservoirs, channel improvements, and floodwalls and levees. However, in spite of the billions of dollars that have already been spent for construction of well-designed and efficient flood control works, annual flood damages continue to increase because the number of persons and structures occupying floodprone lands is increasing faster than protective works can be provided.

Recognition of this trend has forced a reassessment of the flood control concept and resulted in the broadened concept of unified flood plain management programs. Legislative and administrative policies frequently cite two approaches: structural and nonstructural, for adjusting to the flood hazard. In this context, "structural" is usually intended to mean adjustments that modify the behavior of floodwaters through the use of measures such as dams and channel work. "Nonstructural" is usually intended to include all other adjustments in the way society acts when occupying or modifying a flood plain (e.g., regulations, floodproofing, insurance, etc.). Both structural and nonstructural tools are used for achieving desired future flood plain conditions. There are three basic strategies which may be applied individually or in combination: (1) modifying the susceptibility to flood damage and disruption, (2) modifying the floods themselves, and (3) modifying (reducing) the adverse impacts of floods on the individual and the community.

Modify Susceptibility to Flood Damage and Disruption

The strategy to modify susceptibility to flood damage and disruption consists of actions to avoid dangerous, economically undesirable, or unwise use of the flood plain. Responsibility for implementing such actions rests largely with the non-Federal sector and primarily at the local level of government.

These actions include restrictions in the mode and the time of occupancy; in the ways and means of access; in the pattern, density, and elevation of structures and in the character of their materials (structural strength, adsorptiveness, solubility, corrodibility); in the shape and type of buildings and in their contents; and in the appurtenant facilities and landscaping of the grounds. The strategy may also necessitate changes in the interdependencies between flood plains and surrounding areas not subject to flooding, especially interdependencies regarding utilities and commerce. Implementing mechanisms for these actions include land use regulations, development and redevelopment policies, floodproofing, disaster preparedness and response plans, and flood forecasting and warning systems.

Different tools may be more suitable for developed or underdeveloped flood plain or for urban or rural areas. The information contained in this report is particularly useful for the preparation of flood plain regulations.

a. Flood Plain Regulations.

Flood plain regulations apply to the full range of ordinances and other means designed to control land use and construction within floodprone areas. The term encompasses zoning ordinances, subdivision regulations, building and housing codes, encroachment line statutes, open area regulations, and other similar methods of management which affect the use and development of floodprone areas.

Flood plain land use management does not prohibit use of floodprone areas; to the contrary, flood plain land use management seeks the best use of flood plain lands. The flooded area maps and the water surface profiles contained in this report can be used to guide development in the flood plain. The elevations shown on the profile should be used to determine flood heights because they are more accurate than the outlines of flooded areas. It is recommended that development in areas susceptible to frequent flooding adhere to the principles expressed in Executive Order 11988 - Flood Plain Management, whose objective is to "... avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of flood plains ... whenever there is a practicable alternative." Accordingly, development in areas susceptible to frequent flooding should consist of construction that has a low damage potential such as parking areas, parks, and golf courses. High value construction such as buildings should be located outside the flood plain to the fullest extent possible. In instances where no practicable alternative exists, the land should be elevated to minimize damages. If it is uneconomical to elevate the land in these areas, means of floodproofing the structure should be given careful consideration.

b. Development Zones.

A flood plain consists of two zones. The first zone is the designated "floodway" or that cross sectional area required for carrying or discharging the anticipated flood waters with a maximum 1-foot increase in flood level (New York State Department of Environmental Conservation standard). Velocities are the greatest and most damaging in the floodway. Regulations essentially maintain the flow-conveying capability of the floodway to minimize inundation of additional adjacent areas. Uses, which are acceptable for floodways, include parks, parking areas, open spaces, etc.

The second zone of the flood plain is termed the "floodway fringe" or restrictive zone, in which inundation might occur but where depths and velocities are generally low. Although not recommended if practicable alternatives exist, such areas can be developed provided structures are placed high enough or floodproofed to be reasonably free from flood damage during the 1 percent flood. Typical relationships between the floodway and floodway fringe are shown in Figure 2.

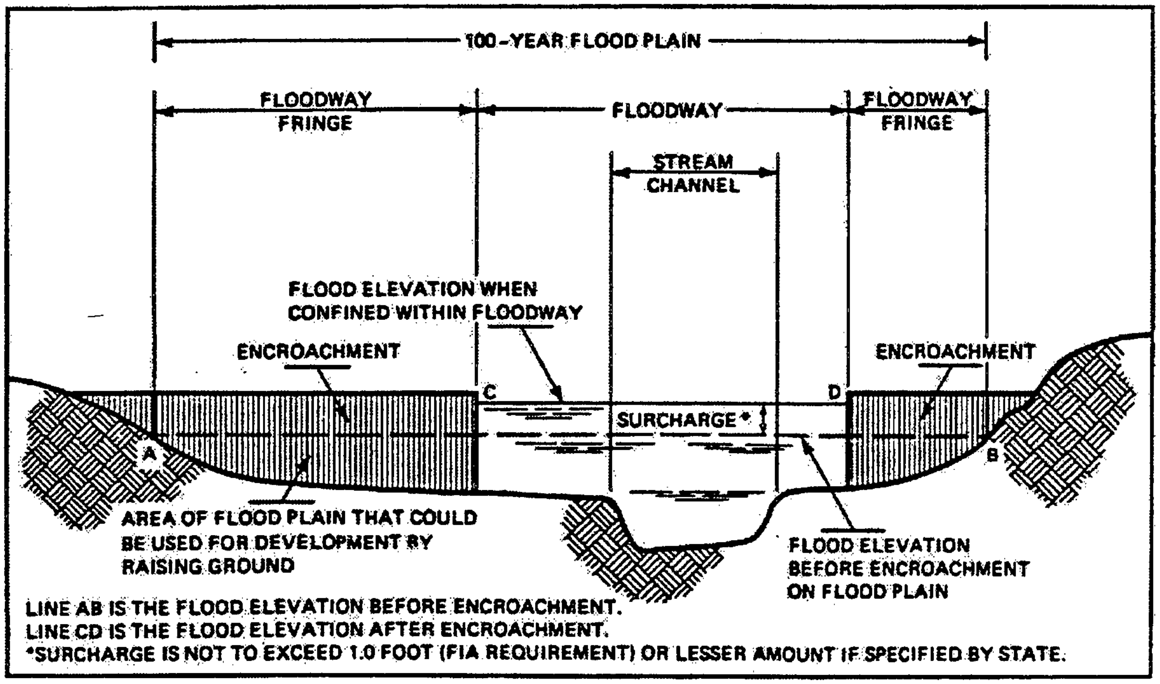


Figure 2 - Floodway Schematic

c. Formulation of Flood Plain Regulations.

Formulation of flood plain regulations in a simplified sense involves selecting the type and degree of control to be exercised for each specific flood plain. In principle, the form of the regulations is not as important as a maintained adequacy of control. The degree of control normally varies with the flood hazard as measured by depth of inundation, velocity of flow, frequency of flooding, and the need for available land. Considerable planning and research is required for the proper formulation of flood plain regulations. Formulation of flood plain regulations may require a lengthy period of time during which development is likely to occur. In such cases, temporary regulations should be adopted and amended later as necessary.

Modify Flooding

The traditional strategy of modifying floods through the construction of dams, dikes, levees and floodwalls, channel alterations, high flow diversions and spillways, and land treatment measures has repeatedly demonstrated its effectiveness for protecting property and saving lives, and it will continue to be a strategy of flood plain management. However, in the future, reliance solely upon a flood modification strategy is neither possible nor desirable. Although the large capital investment required by flood modifying tools has been provided largely by the Federal government, sufficient funds from Federal sources have not been and are not likely to be available to meet all situations for which flood modifying measures would be both effective and economically feasible. Another consideration is that the cost of maintaining and operating flood control structures falls upon local governments.

Flood modifications acting alone leave a residual flood loss potential and can encourage an unwarranted sense of security leading to inappropriate use of lands in the areas that are directly protected or in adjacent areas. For this reason, measures to modify possible floods should usually be accompanied by measures to modify the susceptibility to flood damage, particularly by land use regulations.

Modify the Impact of Flooding on Individuals and the Community

A third strategy for mitigating flood losses consists of actions designed to assist individuals and communities in their preparatory, survival, and recovery responses to floods. Tools include information dissemination and education, arrangements for spreading the costs of the loss over time, purposeful transfer of some of the individual's loss to the community by reducing taxes in flood prone areas, and the purchase of Federally subsidized flood insurance.

The distinction between a reasonable and unreasonable transfer of costs from the individual to the community can also be regulated and is a key to effective flood plain management.

CONCLUSION

Changes in hydrology and hydraulics reflected in this study are the result of a more detailed analysis, primarily new procedures and additional flow data, of Tonawanda Creek. This is particularly true for the reach downstream of the gauge station. The Prospect Road vicinity was more accurately modeled in this study; additionally, flows introduced by Tunnery Brook were accounted for in the current study.

This report presents local flood hazard information for Tonawanda Creek in the Village of Attica, New York. The U.S. Army Corps of Engineers, Buffalo District, will provide interpretation in the application of the data contained in this report, particularly as to its use in developing effective flood plain regulations. Requests should be coordinated with the New York State Department of Environmental Conservation.

GLOSSARY

BACKWATER EFFECT	The resulting rise in water surface in a given stream due to a downstream obstruction or high stages in an intersecting stream.
BASE FLOOD	A flood which has an average return interval in the order of once in 100 years, although the flood may occur in any year. It is based on statistical analysis of streamflow records available for the watershed and analysis of rainfall and runoff characteristics in the general region of the watershed. It is commonly referred to as the "100-year flood."
DISCHARGE	The quantity of flow in a stream at any given time, usually measured in cubic feet per second (cfs).
FLOOD	An overflow of lands not normally covered by water. Floods have two essential characteristics: the inundation of land is temporary and the lands are adjacent to and inundated by overflow from a river, stream, ocean, lake, or other body of standing water. Normally a "flood" is considered as any temporary rise in streamflow or stage, but not the ponding of surface water, that results in significant adverse effects in the vicinity. Adverse effects may include damages from overflow of land areas, temporary backwater effects in sewers and local drainage channels, creation of unsanitary conditions or other unfavorable situations by deposition of materials in stream channels during flood recessions, and rise of groundwater coincident with increased streamflow.
FLOOD CREST	The maximum stage or elevation reached by floodwaters at a given location.
FLOOD FREQUENCY	A statistical expression of the percent chance of exceeding a discharge of a given magnitude in any given year. For example, a <u>100-year flood</u> has a magnitude expected to be exceeded on the average of once every hundred years. Such a <u>flood</u> has a 1 percent chance of being exceeded in any given year. Often used interchangeably with <u>RECURRENCE INTERVAL</u>.
FLOOD PLAIN	The areas adjoining a river, stream, watercourse, ocean, lake, or other body of standing water that have been or may be covered by floodwater.
FLOOD PROFILE	A graph showing the relationship of water surface elevation to location; the latter generally expressed as distance upstream from a known point along the approximate centerline of a stream of water that flows in an open channel. It is generally drawn to show surface elevation for the rest of a specific flood, but may be prepared for conditions at a given time or stage.
FLOOD STAGE	The stage or elevation at which overflow of the natural banks of a stream or body of water begins in the reach or area in which the elevation is measured.

FLOODWAY — The channel of a watercourse and those portions of the adjoining flood plain required to provide for the passage of the selected flood (normally the 100-year flood) with an insignificant increase in the flood levels above that of natural conditions. As used in the National Flood Insurance Program, floodways must be large enough to pass the 100-year flood without causing an increase in elevation of more than a specified amount (1 foot in most areas).

RECURRENCE INTERVAL — A statistical expression of the average time between floods exceeding a given magnitude (see FLOOD FREQUENCY).

REFERENCES

1. U.S. Department of Commerce, Bureau of the Census, 1990 Census of the Population and Housing, Washington, D.C.

2. Federal Emergency Management Agency, Flood Insurance Study, Village of Attica, Genesee and Wyoming Counties, New York, Washington, D.C. July 1986.

3. U.S. Department of the Interior, Interagency Advisory Committee on Water Data, Hydrology Subcommittee, Guidelines for Determining Flood Flow Frequency, March 1982.

4. U.S. Army Corps of Engineers, Hydrologic Engineering Center's Flood Flow Frequency Computer Program (HEC-FFA), Version 3.1, February 1995.

5. U.S. Department of the Interior, Geological Survey, Regionalization of Flood Discharges for Rural, Unregulated Streams in New York, Excluding Long Island, Water Resources Investigation Report 90-4197, 1990.

6. U.S. Department of the Interior, Geological Survey, 7.5 Minute Series (Topographic) Map, Scale 1:24,000, Contour Interval 10 feet: Attica, NY (Photo revised 1978).

7. U.S. Department of the Interior, Geological Survey, Digital Elevation Model, 1-degree DEM, Attica, NY.

8. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-RAS, River Analysis System, Version 2.2, Davis, California, 1988.

Summary of Hydrology

A discharge-frequency relationship for the stream gage on Tonawanda Creek @ Attica (#04216418) was calculated using the guidelines established in Bulletin17b, "Guidelines for Determining Flood Flow Frequency," by the Hydrology Subcommittee, Interagency Advisory Committee on Water Data, U.S. Department of the Interior, March 1982. Version 3.1 of the Corps ' Hydrologic Engineering Center's Flood Flow Frequency computer program (HEC-FFA) dated February 1995 was used to determine the relationship. Stream gage data for the period of Water Years 1978 through 1998 (21 years of record) were used in this analysis. There is a historical peak discharge of 6,000 cfs on June 23, 1972 (Tropical Storm Agnes). Table 1 contains the peak discharge values used for this analysis.

An analysis of the raw flow data (using HEC-FFA) found a high outlier (July 8, 1998, 9,400 cfs). Bulletin 17b requires a historical analysis of flooding on a stream to determine the period of knowledge, i.e., what year (if any) was there a documented historical flood higher then the high outlier. The historical flood of June 1972 was lower then the July 1998 so it can't be used to determine the period of knowledge. There is a stream gage on Tonawanda Creek downstream of Attica at Batavia (#0421700) that has a period of record going back to July 1944. The highest recorded flow at Batavia was on 31 March 1960. The peak stage of record at Batavia was 14.5 feet measured during March 1942, but the U. S. Geological Survey did not associated a peak flow with this stage, so I used the period back to 1960 as the period of knowledge. Since the historical peak discharge measured in June 1972 was less then the recorded discharge of July 1998, the historical discharge was not used in the analysis.

The period of knowledge back to 1960 was then used in the Bulletin 17b analysis (HEC-FFA) and the discharge-frequency relation was calculated. The discharge-frequency relationship is found on Table 2, and the discharge-frequency curve is shown on Figure 1.

Since the confluence of Tannery Brook and Tonawanda Creek is within the study boundaries, 2 hydrologic regions were delineated for this study. The first reach (#1) is from the downstream study limit to just downstream of Tannery Brook and the second reach (#2) is from just upstream of the Tannery Brook to the upstream study limit. The discharge-frequency relationship calculated at the gage was used for Reach #2. The guidelines of the U. S. Geological Survey's Water Resources Investigation Report 90-4197 (WRI 90-4147): "Regionalization of Flood Discharges for Rural, Unregulated Streams in New York, excluding Long Island," 1991, for ungaged areas on gaged streams was used to calculate the discharge-frequency relationship for Reach #1. **Plate 1** shows the Tonawanda Creek Watershed. **Plate 2** shows the delineated reaches. The discharge-frequency relationship for Reach #1 is found on **Table 3** and shown on **Figure 2.**

Table 1: Annual Peak Discharges

Water Year	Peak Discharge (cfs)	Rank	Weibull Plotting Position
1978	4,500	4	15.63
1979	4,690	3	10.88
1980	2,460	16	72.63
1981	3,020	10	44.13
1982	2,090	19	86.88
1983	1,430	21	96.38
1984	2,800	12	53.63
1985	4,700	2	6.13
1986	3,290	6	25.13
1987	2,610	15	67.88
1988	2,200	18	82.13
1989	3,520	5	20.38
1990	2,610	14	63.13
1991	3,190	7	29.88
1992	3,070	9	39.38
1993	2,080	20	91.63
1994	2,230	17	77.38
1995	2,650	13	58.38
1996	3,150	8	34.63
1997	2,810	11	48.88
1998	9,400	1	2.50

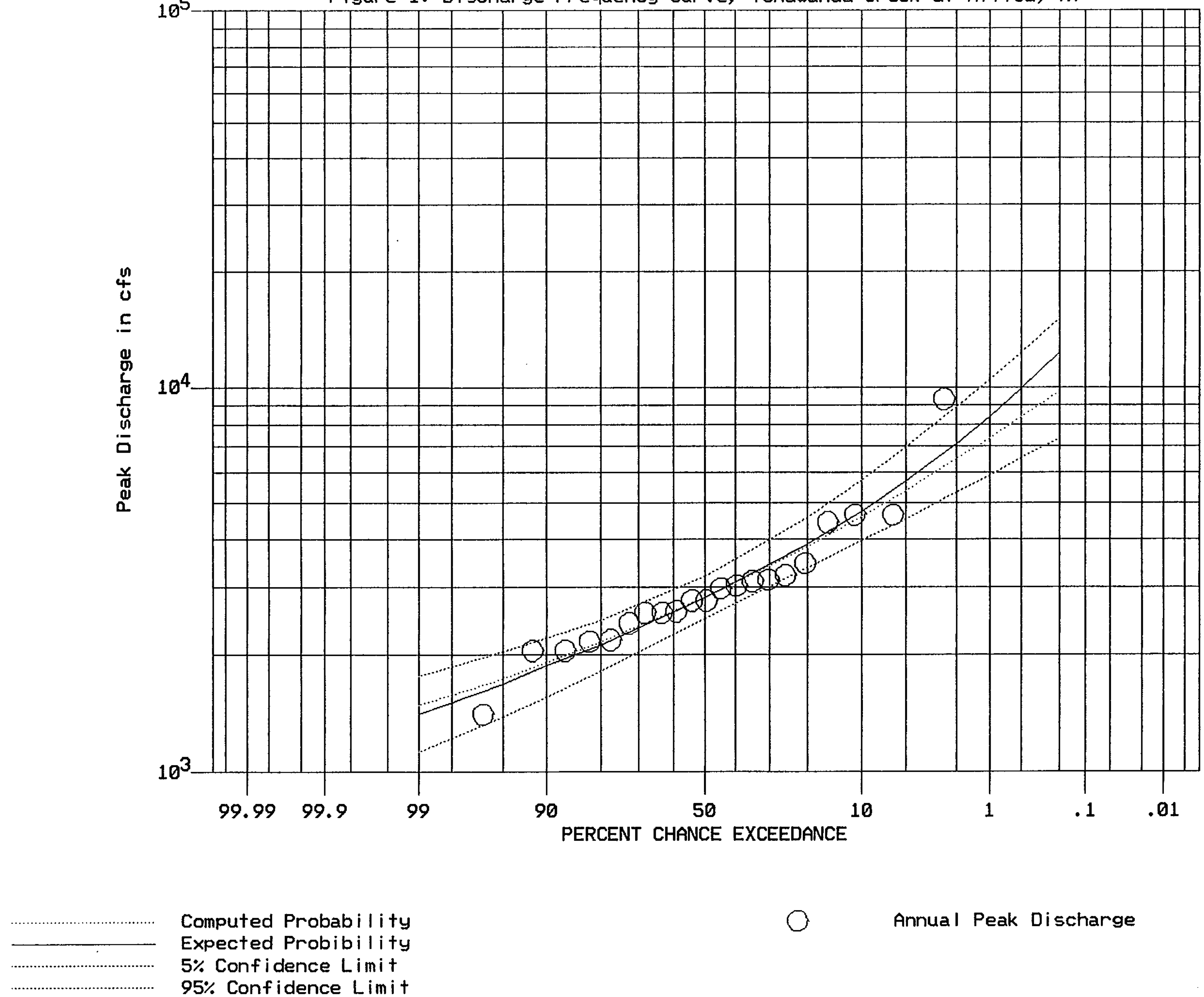
Table 2: Discharge-Frequency Relationship @ Gage (Reach 2)

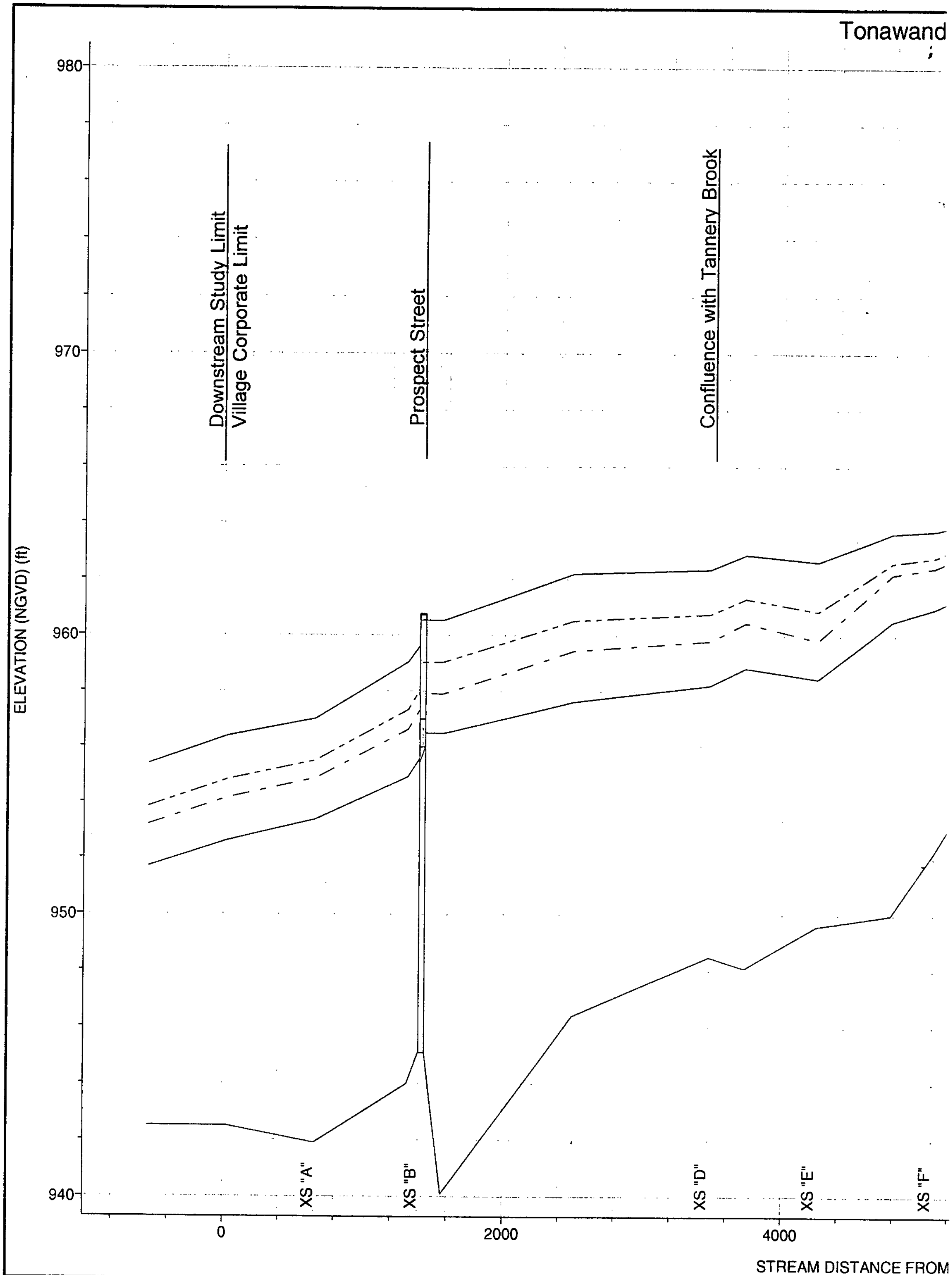
Frequency (%)	Return Interval (years)	Expected Peak Flow (cfs)	Computed Peak Flow (cfs)	5% Confidence Limit (cfs)	95% Confidence Limit (cfs)
0.2	500	9,740	12,400	15,200	7,420
0.5	200	8,350	9,920	12,400	6,550
1.0	100	7,390	8,400	10,500	5,920
2.0	50	6,490	7,120	8,890	5,320
5.0	20	5,400	5,690	6,980	4,560
10.0	10	4,620	4,770	5,750	3,980
20.0	5	3,820	3,930	4,580	3,400
50.0	2	2,840	2,840	3,230	2,490
80.0	-	2,180	2,150	2,480	1,830
90.0	-	1,920	1,890	2,220	1,570
95.0	-	1,750	1,700	2,040	1,390
99.0	-	1,490	1,410	1,780	1,130

Discharge Table 3: -Frequency Relationship @ Gage (Reach 2)

Frequency (%)	Return Interval (years)	Peak Flow (cfs)
0.2	500	
0.5	200	
1.0	100	
2.0	50	
5.0	20	
10.0	10	
20.0	5	
50.0	2	
80.0	-	
90.0	-	
95.0	-	
99.0	-	

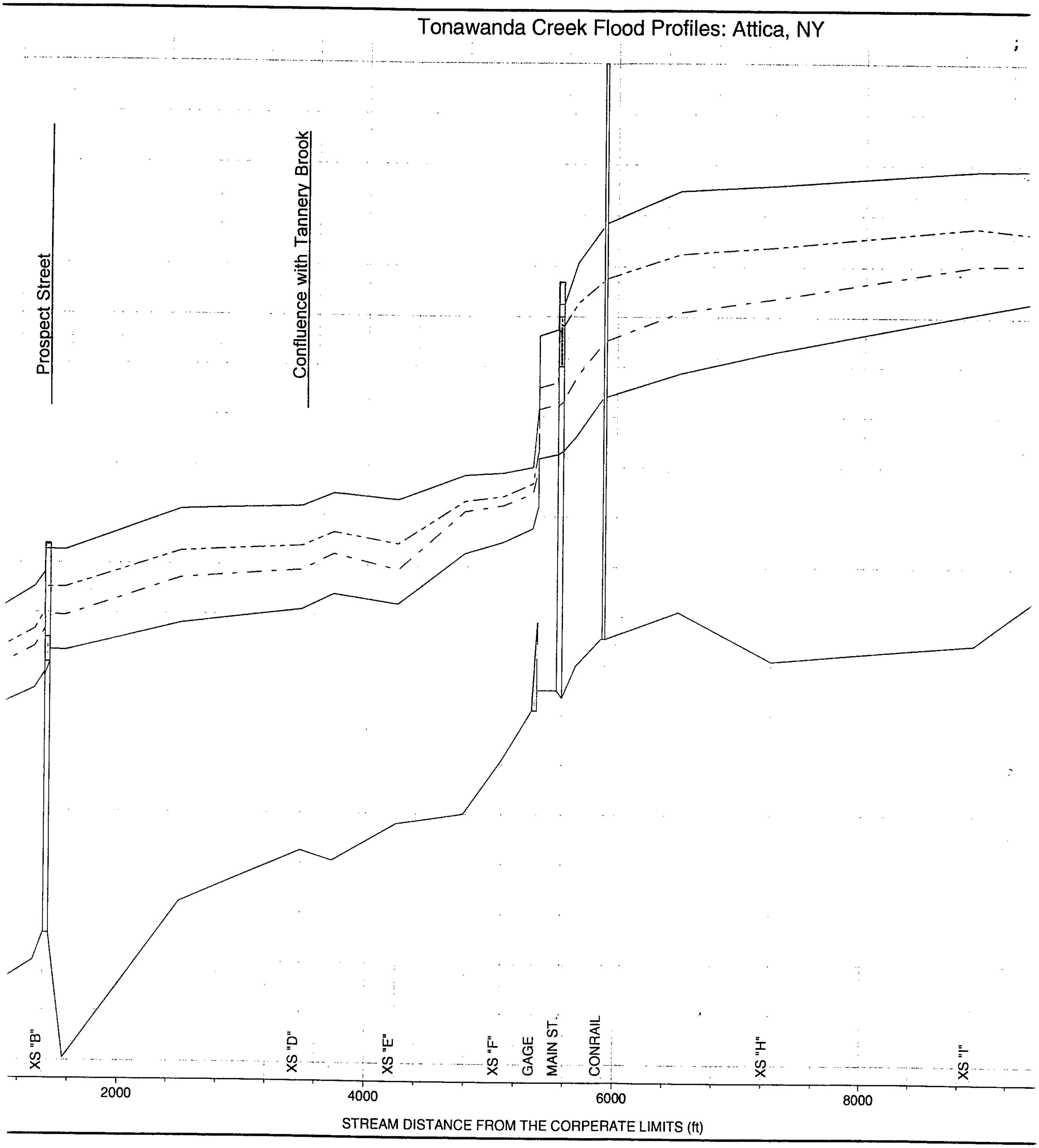
Figure 1: Discharge-Frequency Curve, Tonawanda Creek at Attica, NY



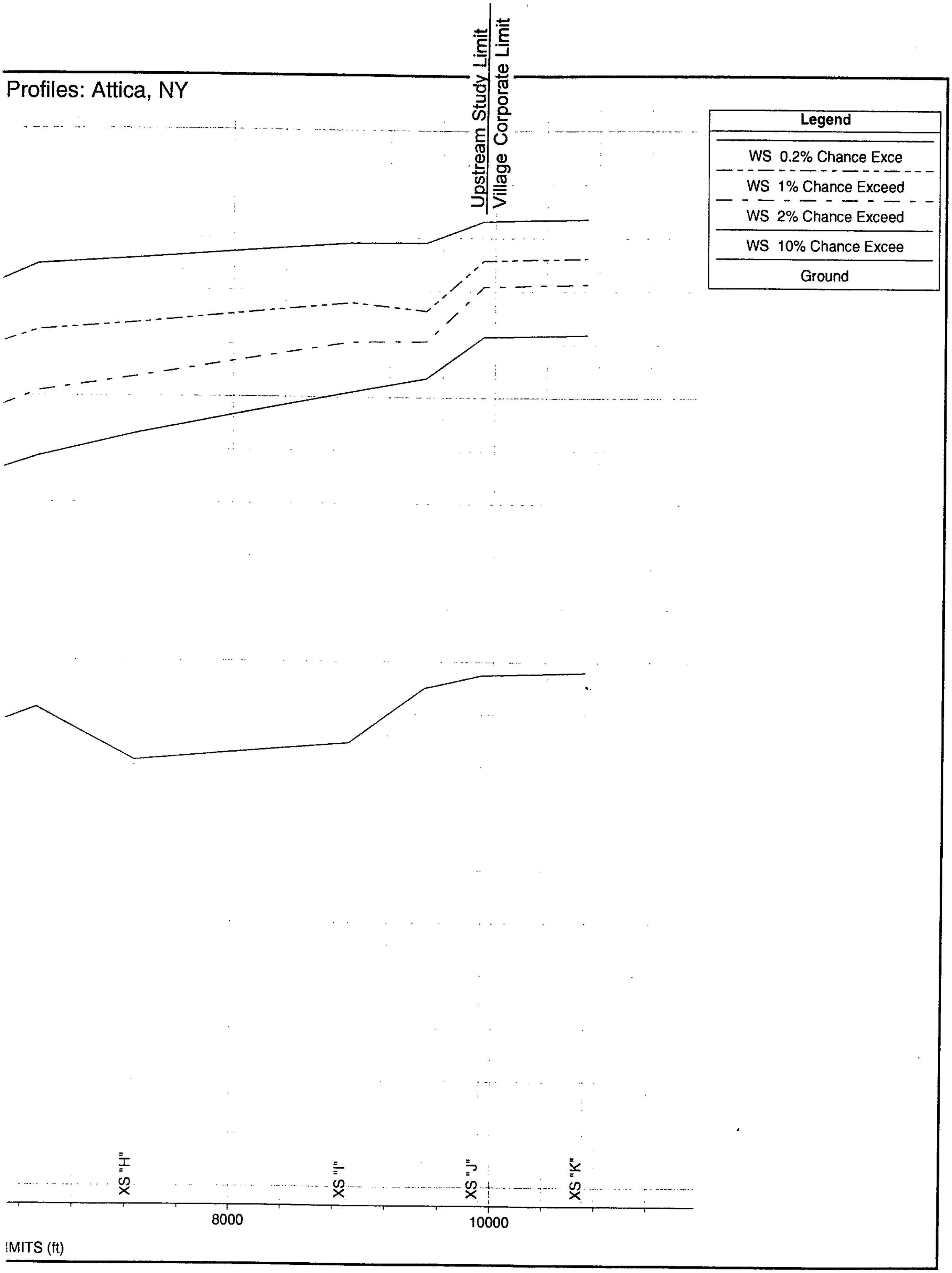


1 in Horiz. = 1000 ft   1 in Vert. = 5 ft

1

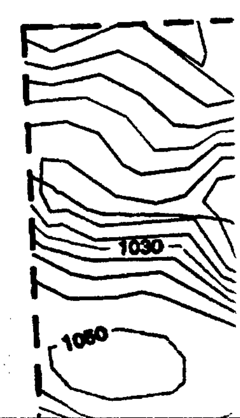

Tonawanda Creek Flood Profiles: Attica, NY
Prospect Street
Confluence with Tannery Brook
XS "B"
XS "D"
XS "E"
XS "F"
GAGE
MAIN ST.
CONRAIL
XS "H"
XS "I"
2000
4000
6000
8000
STREAM DISTANCE FROM THE CORPERATE LIMITS (ft)

2



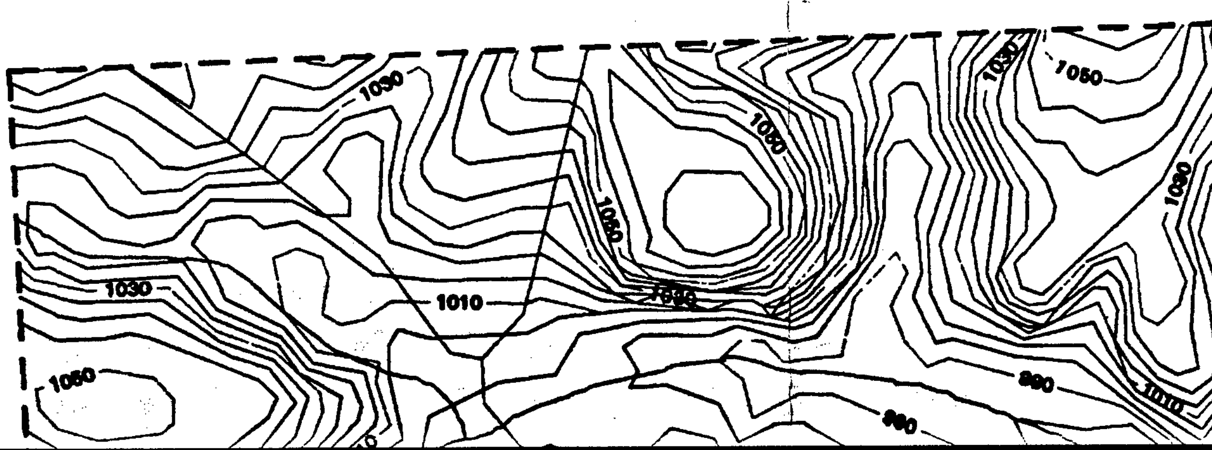
Profiles: Attica, NY
Upstream Study Limit
Village Corporate Limit
Legend
WS 0.2% Chance Exce
WS 1% Chance Exceed
WS 2% Chance Exceed
WS 10% Chance Excee
Ground
XS "H"
XS "I"
XS "J"
XS "K"
8000
10000
IMITS (ft)

3



1

2



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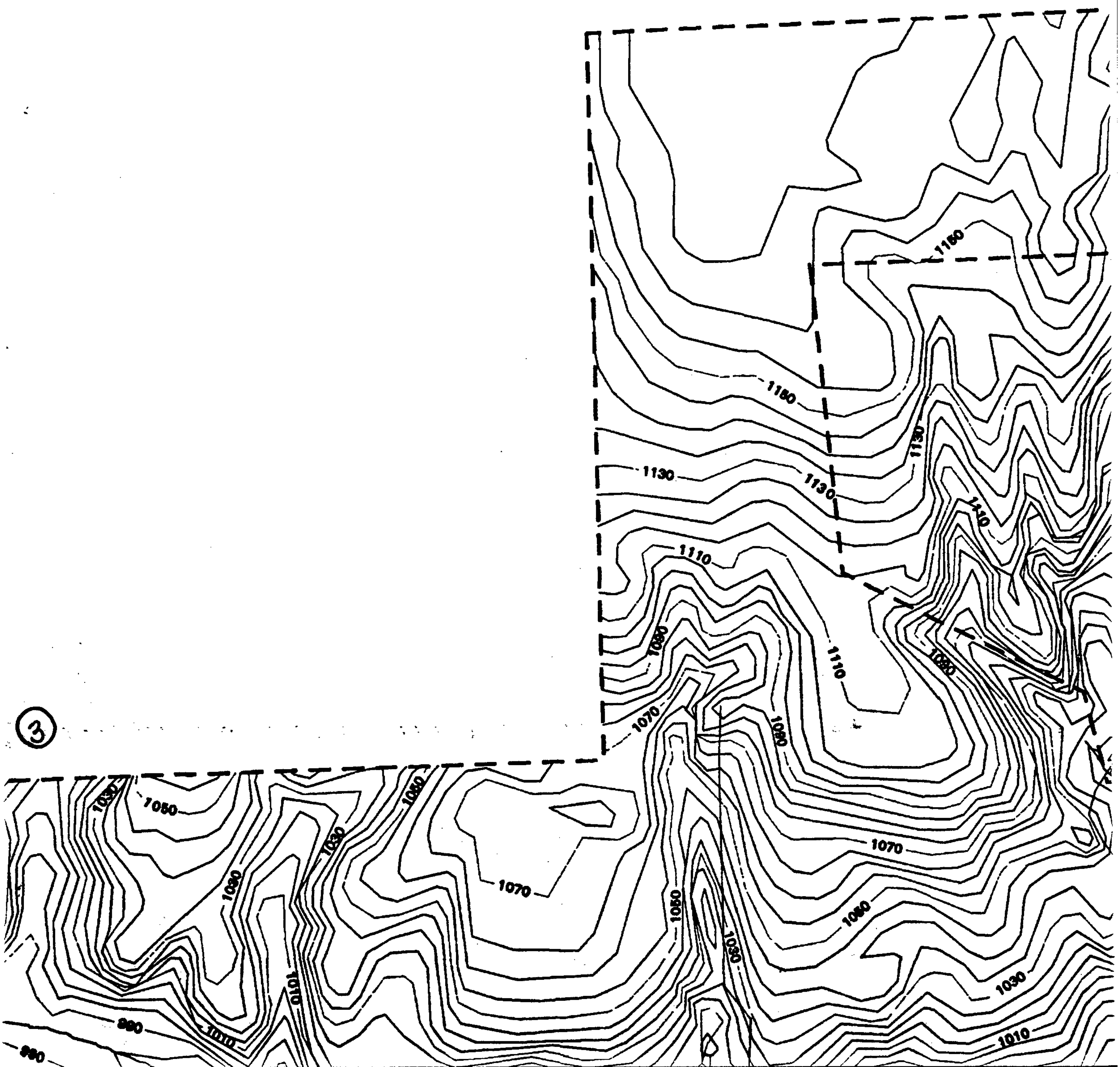

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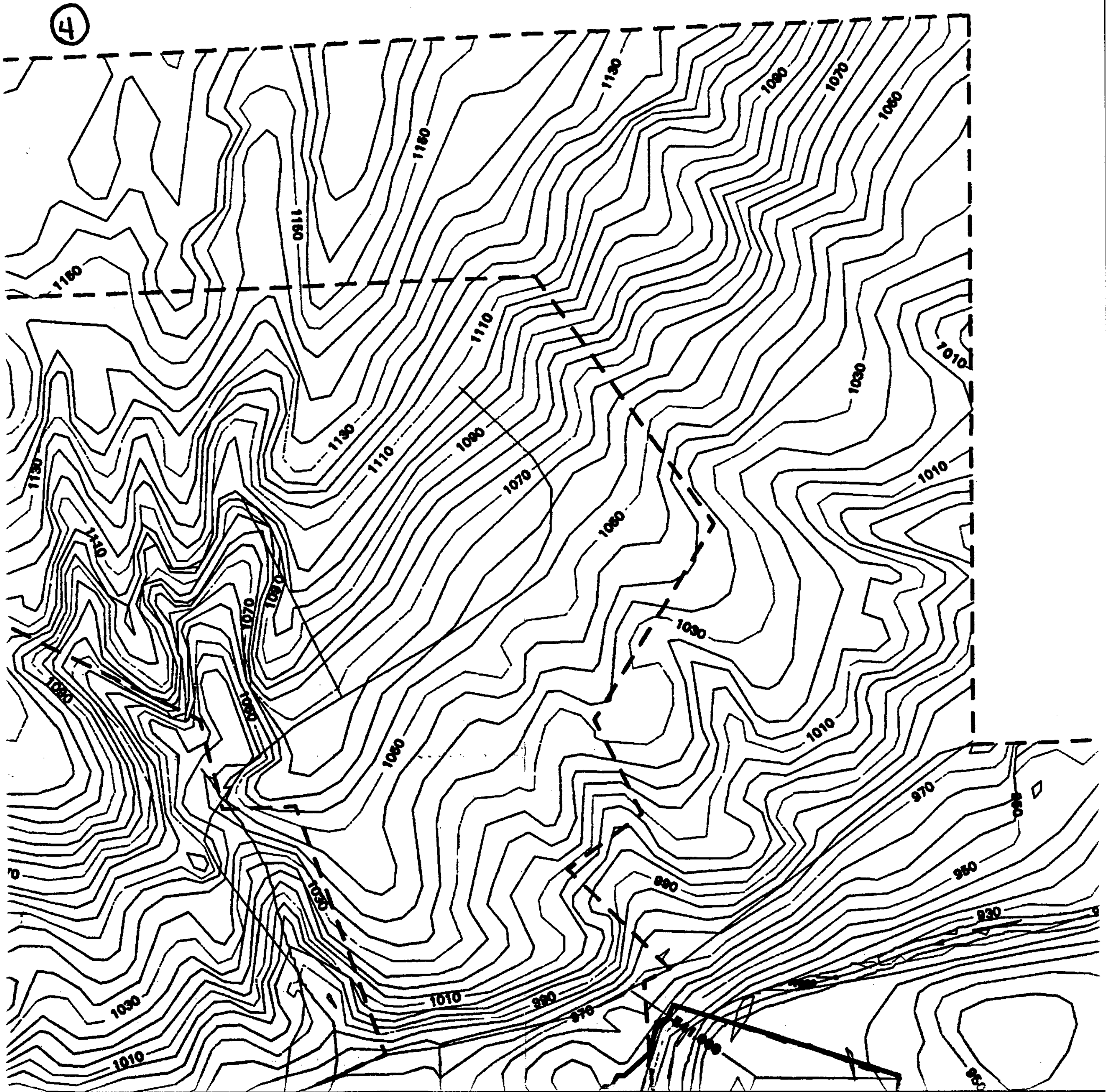
1030
1010
1010
1010
990
990

4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1150
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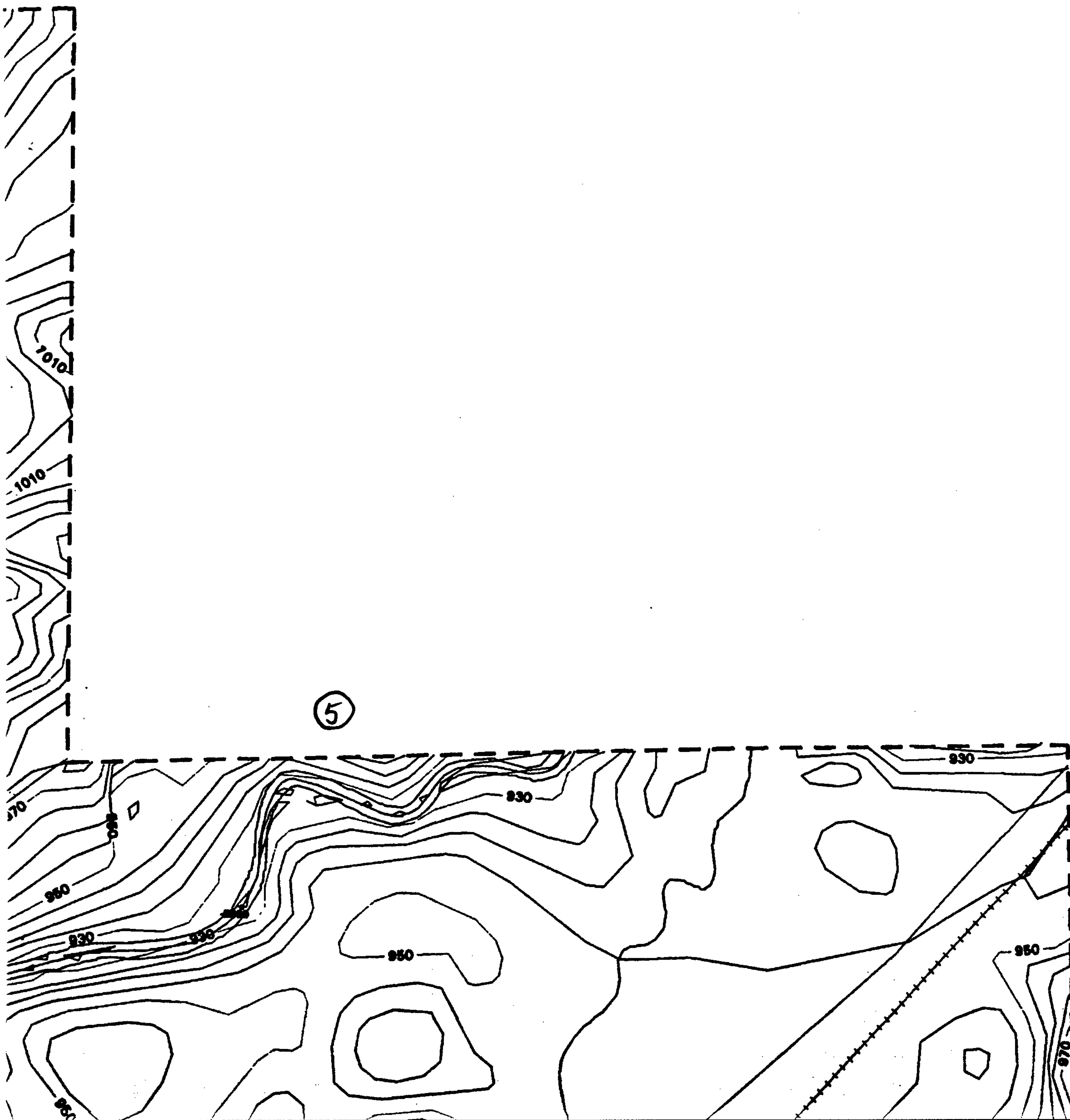
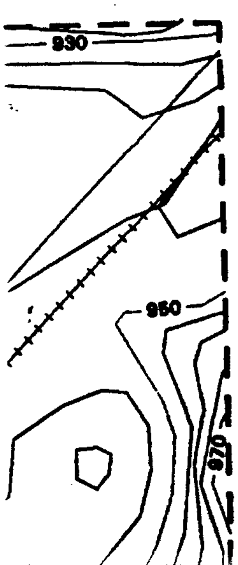
1110
1090
1030
1010
1060
970
950
930
990
1020
1040
960

5





D

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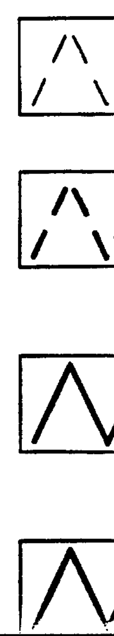


DRAFT

PLOT

KEY

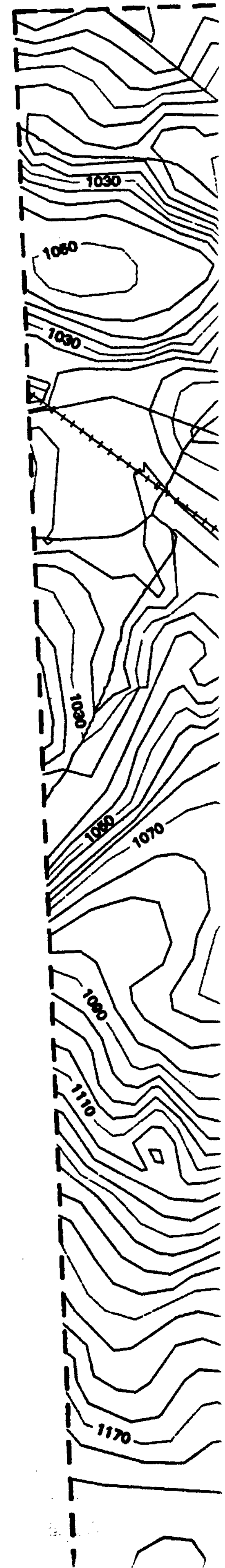
Floodway

100yr Boundary

500yr Boundary

BFE

7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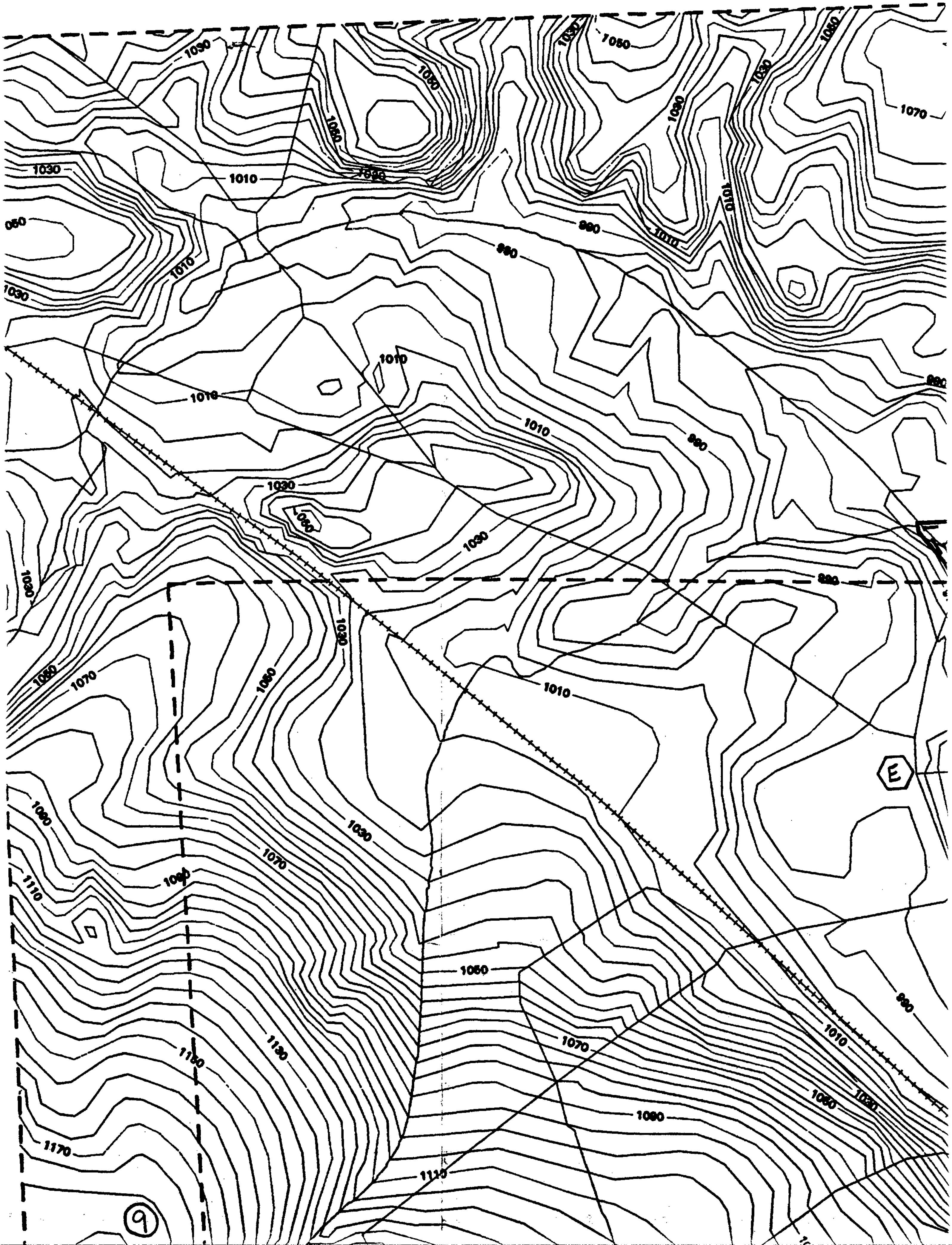

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1090
1170
1110
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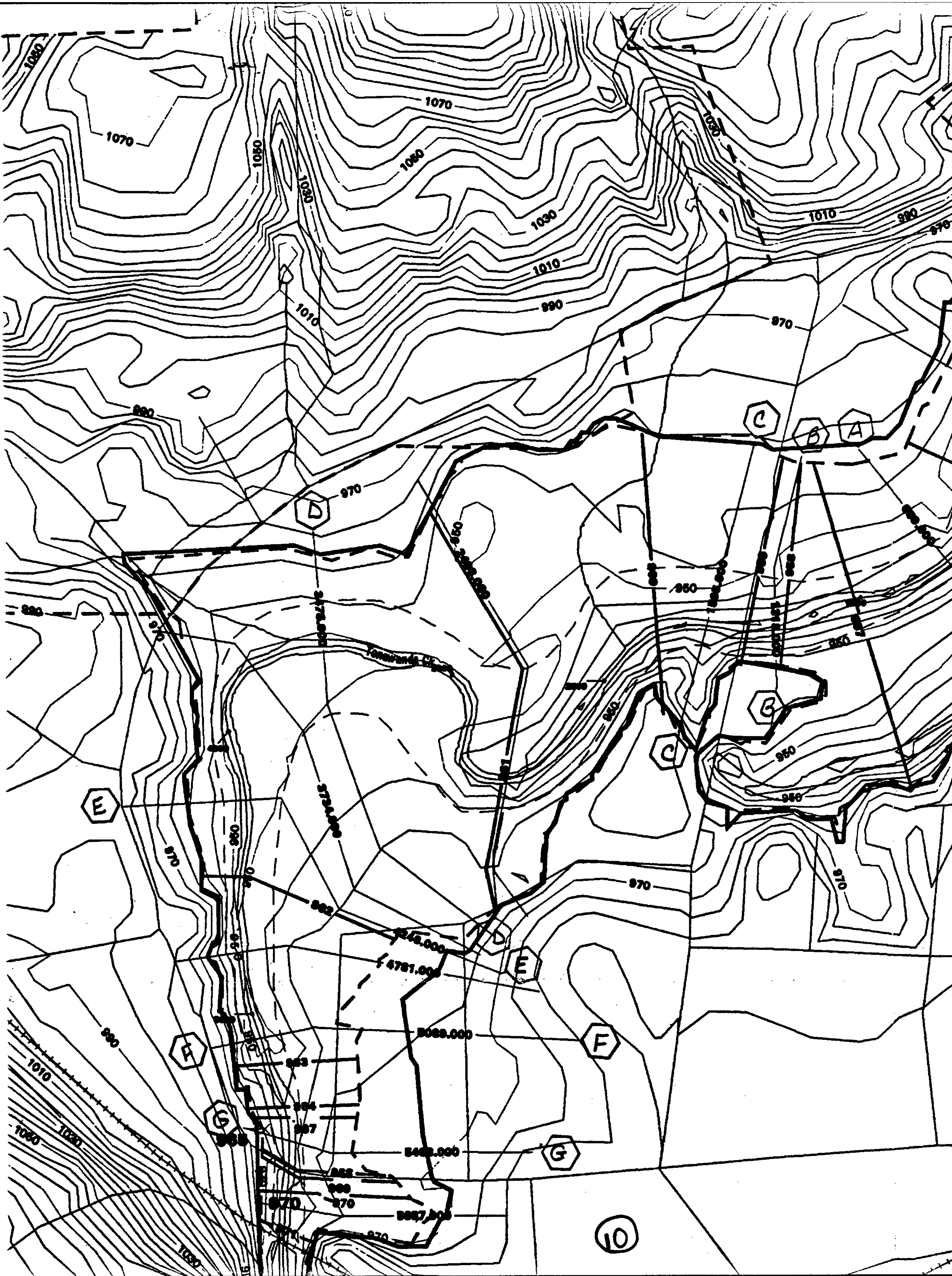
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B
A
D
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950
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960
E
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970
970
962
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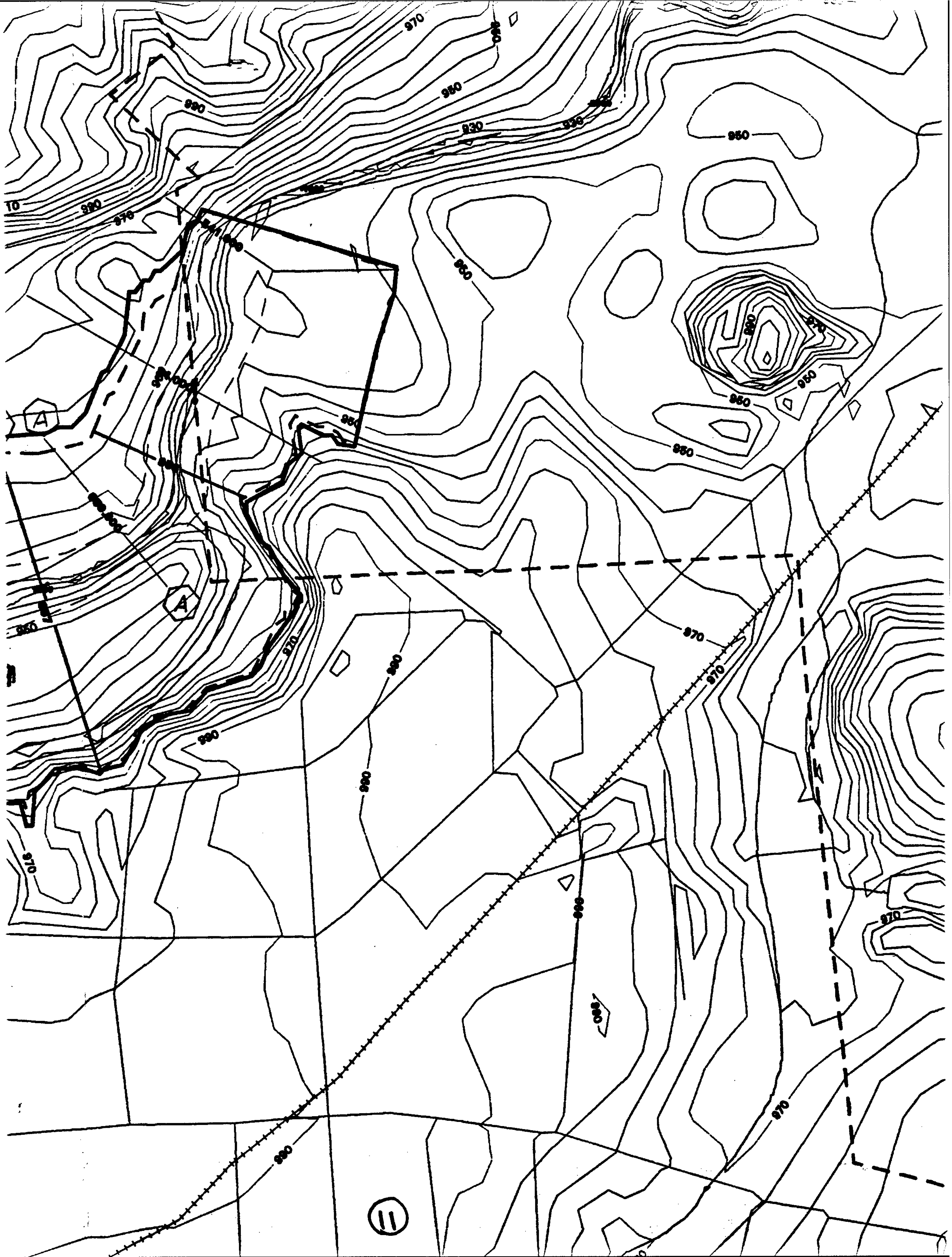
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970
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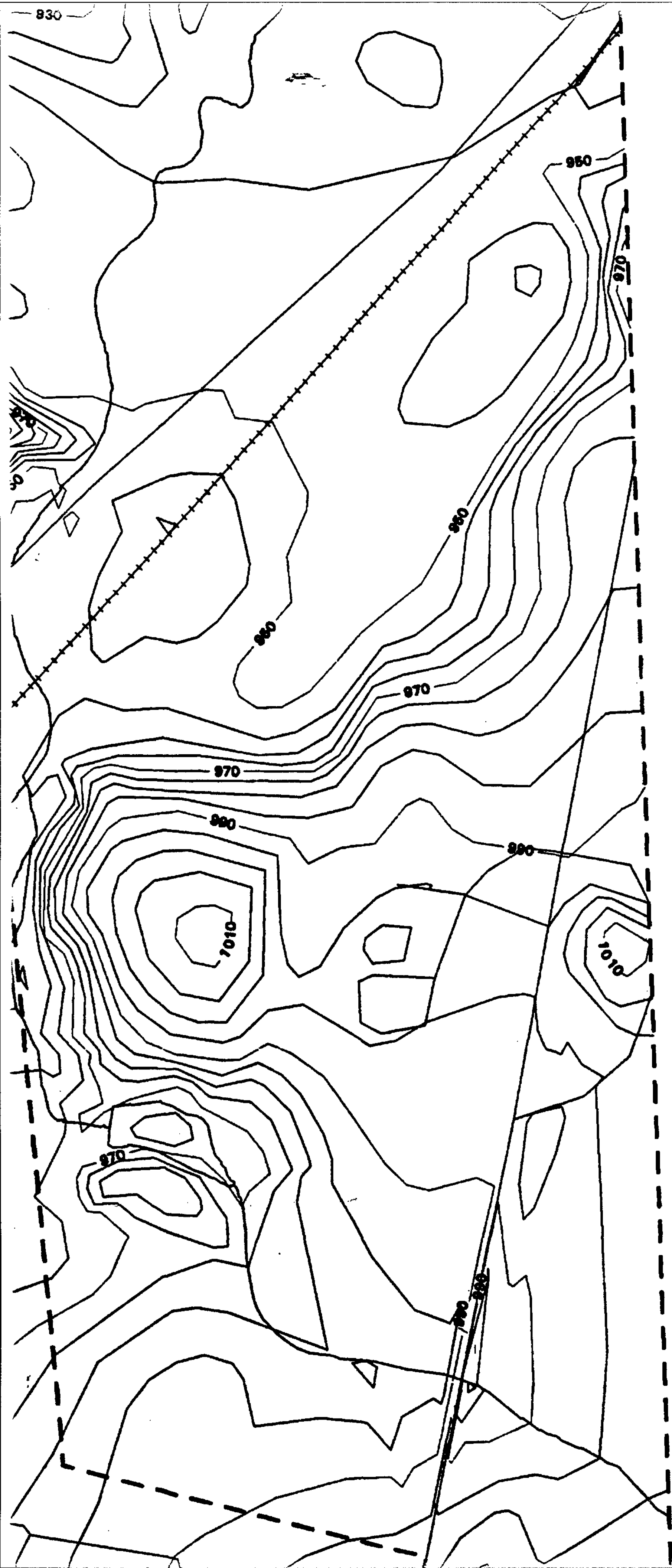


12

100yr Boundary

500yr Boundary

BFE

Study Limits

River Center

River Banks

Cross Section

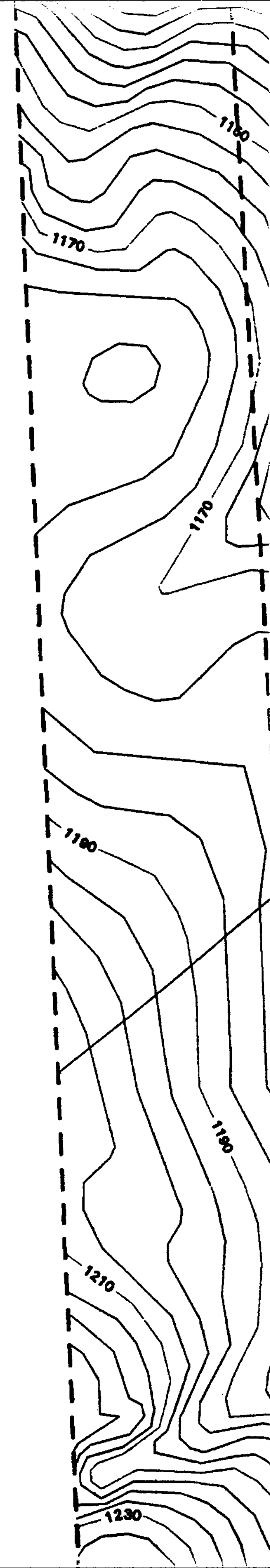
Streets

Railroads

Political Boundary

Model Limits

Area Not Included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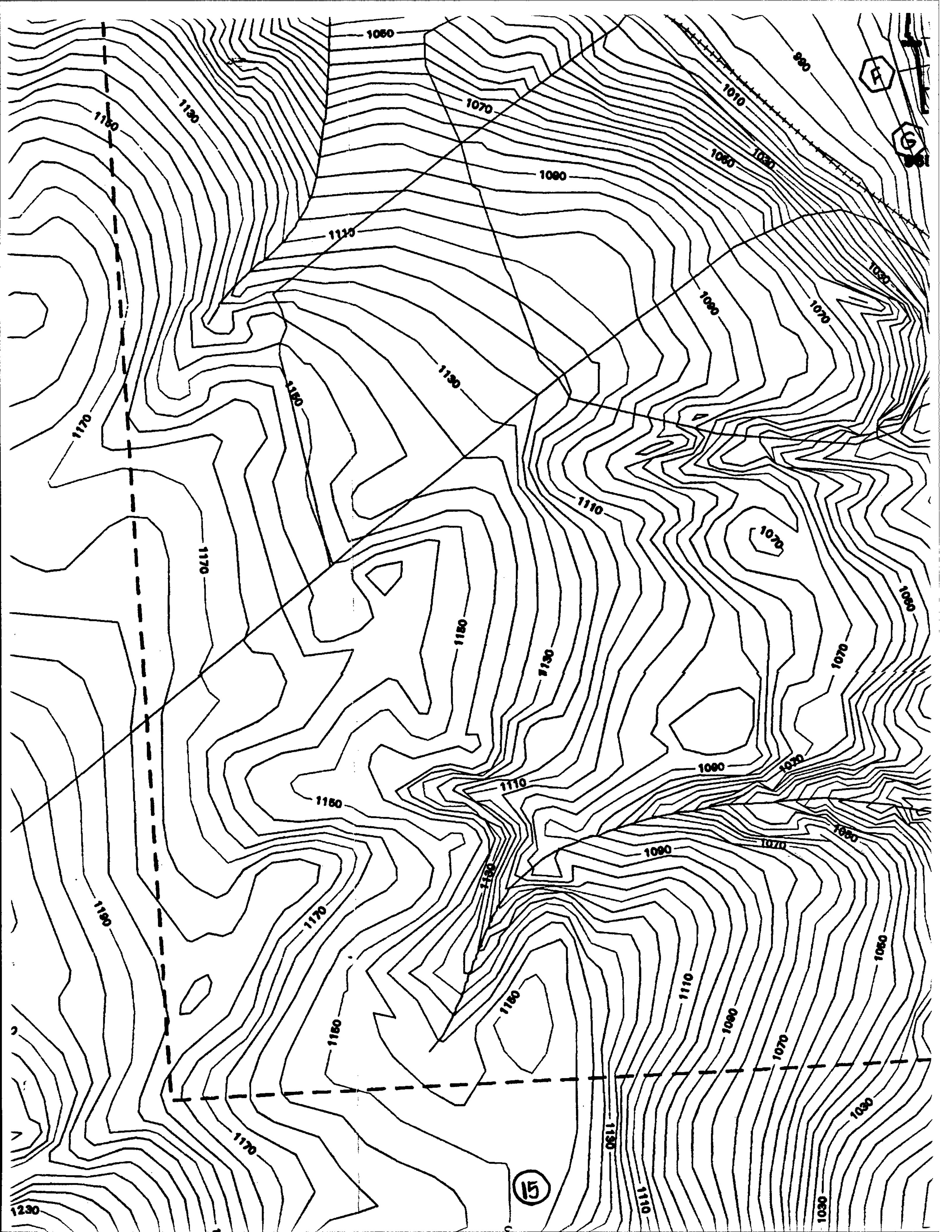

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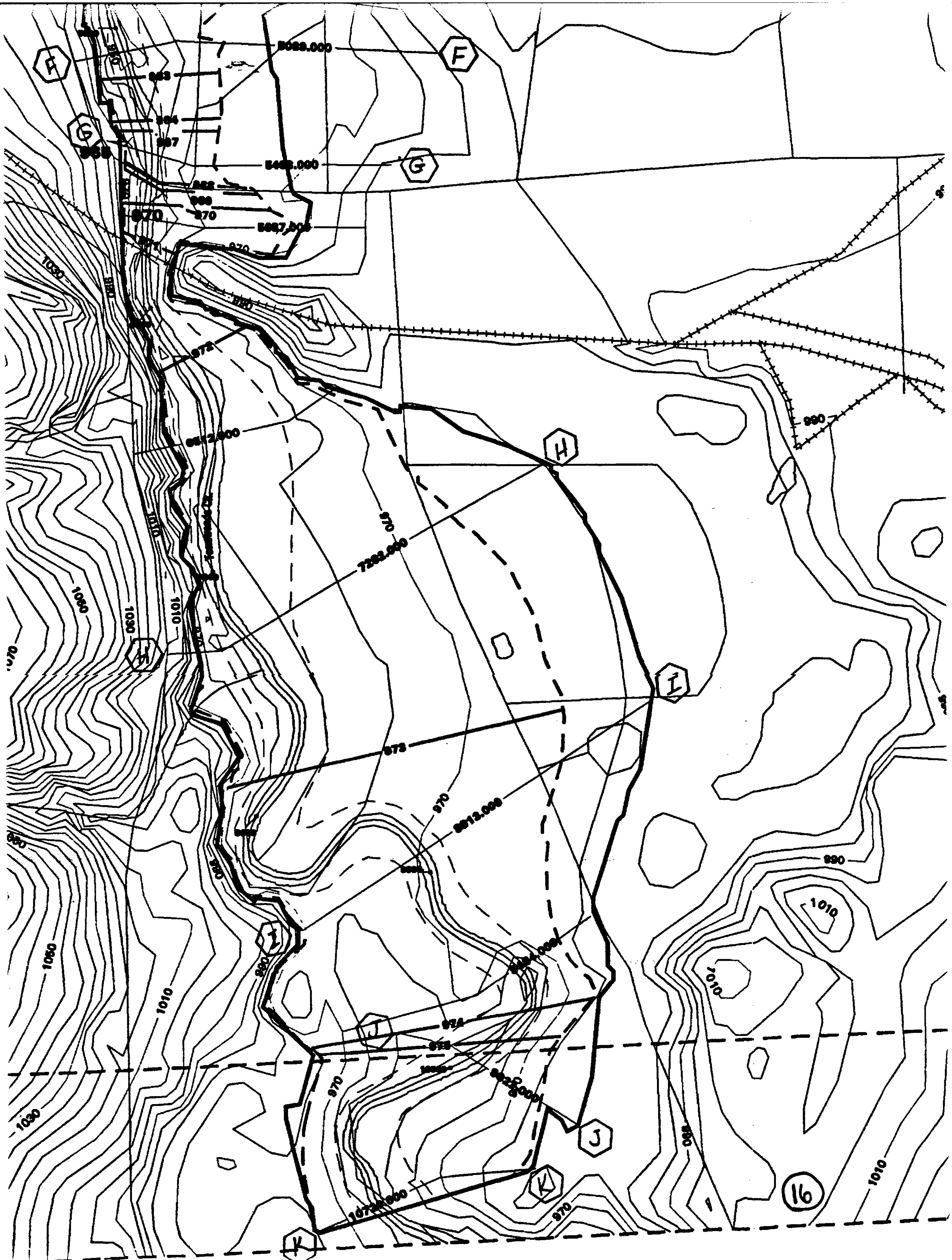

F
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G
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I
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K
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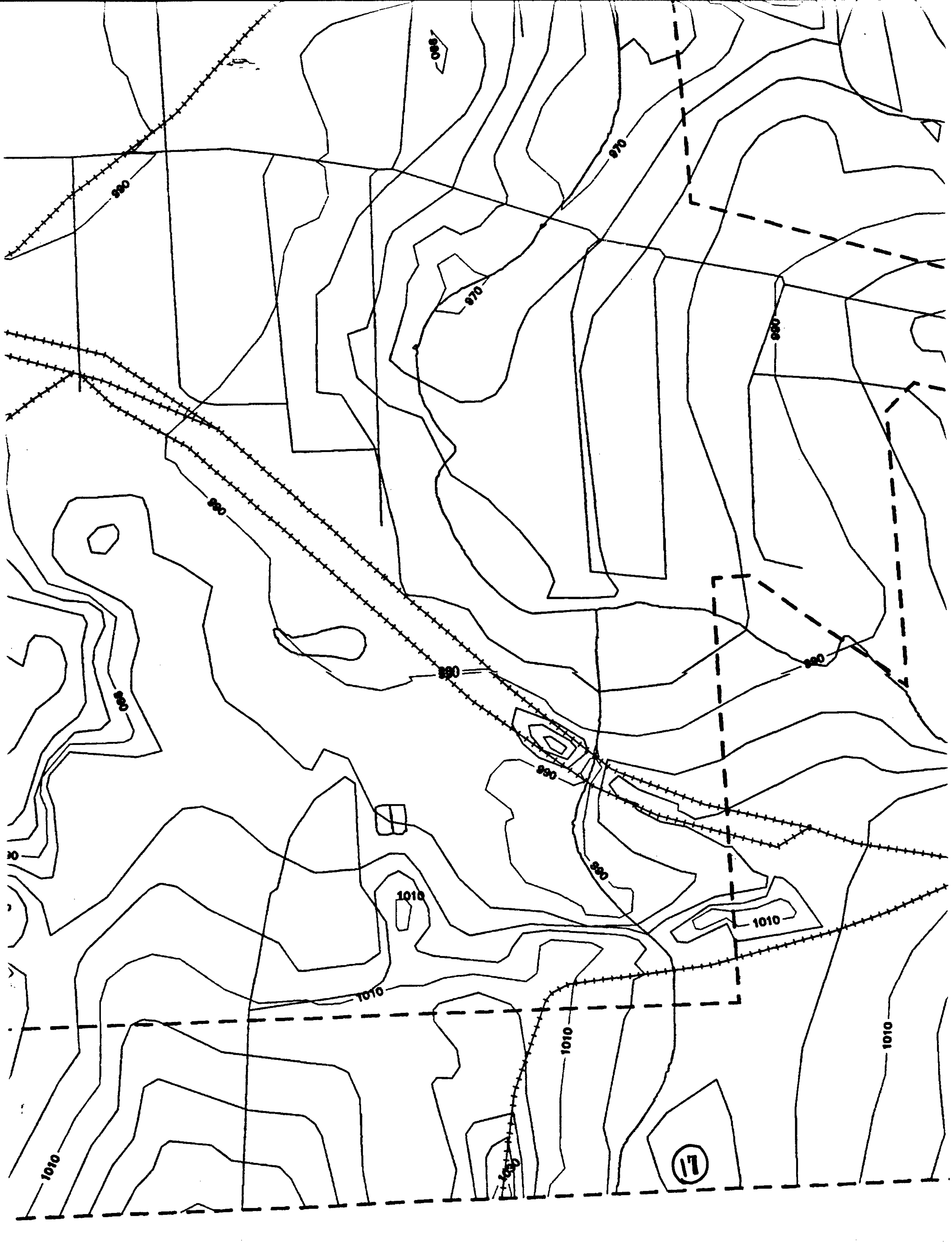
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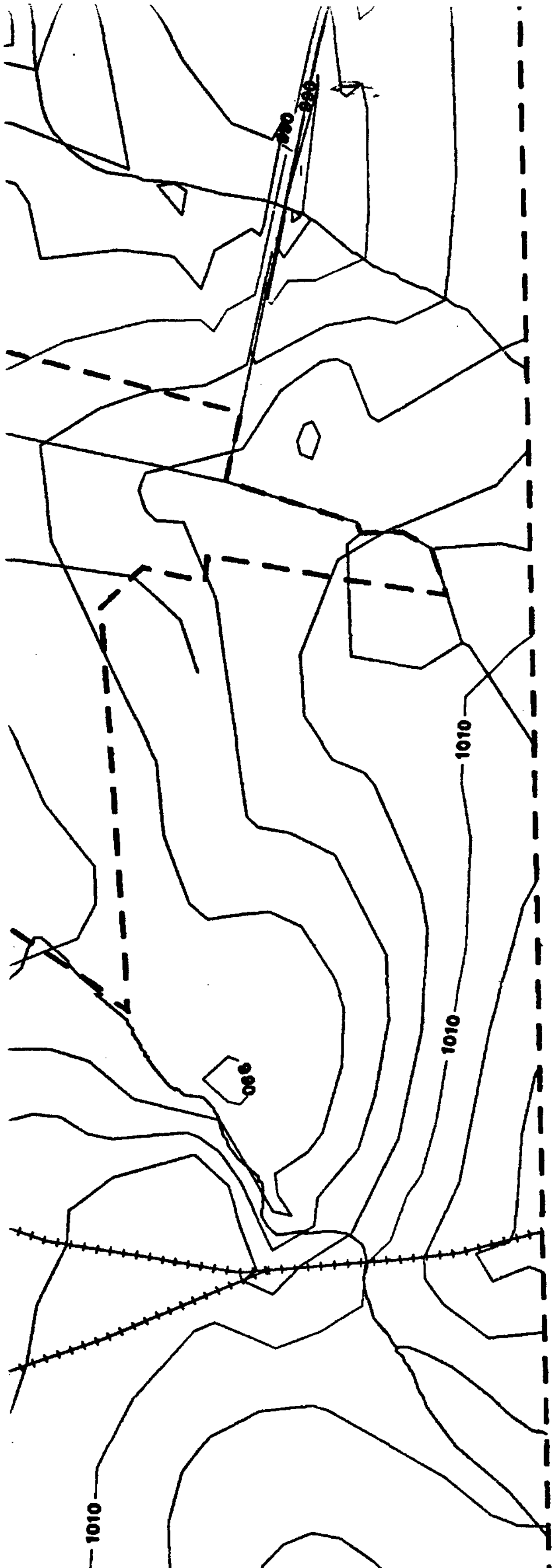
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Boundary

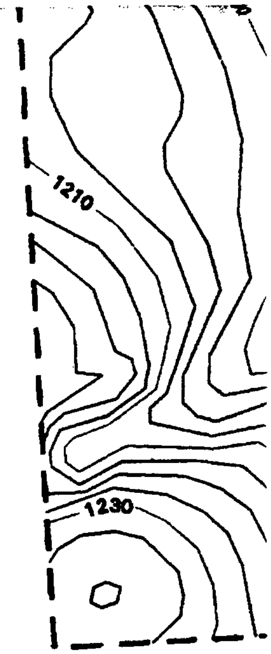
Model
Limits

Area Not
Included

5 ft
Contours

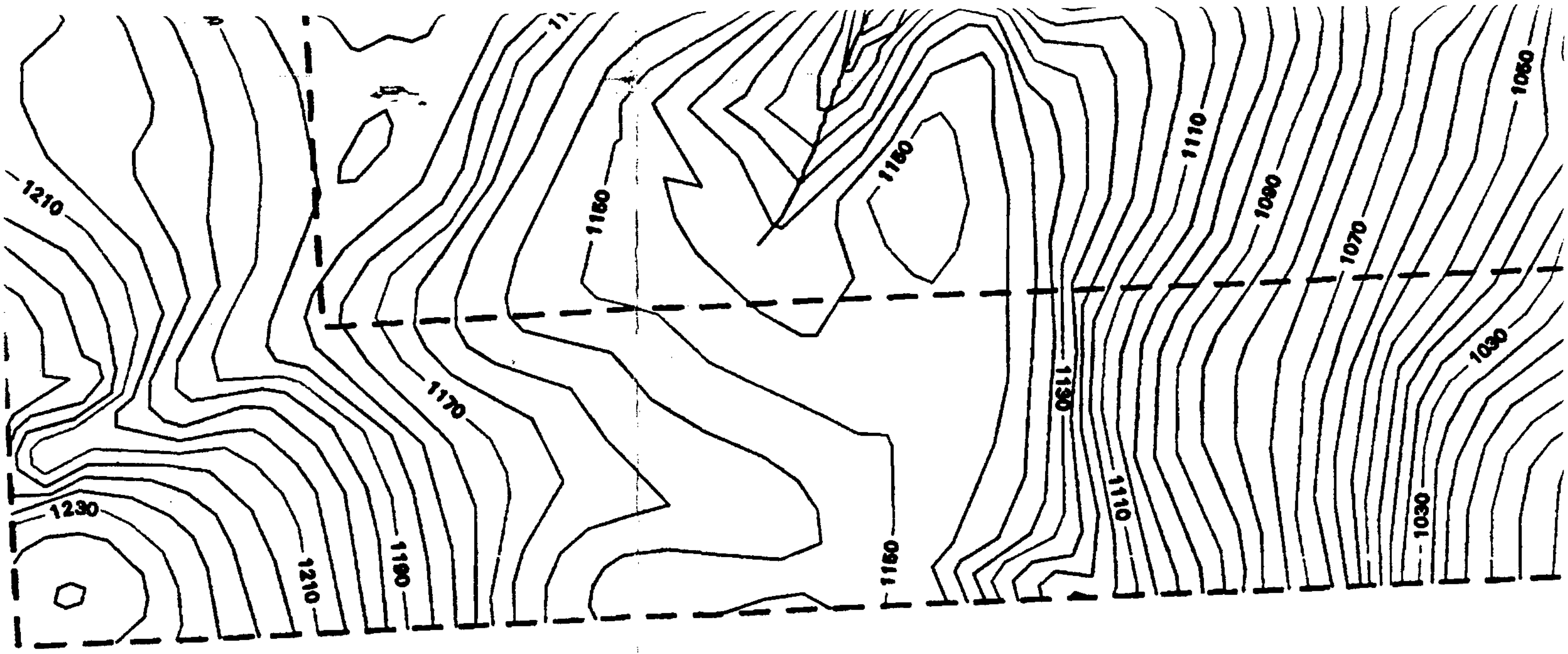
20 ft
Contours

ERM



SPECIAL FLOOD HAZARD STUDY
VILLAGE OF ATTICA, NY

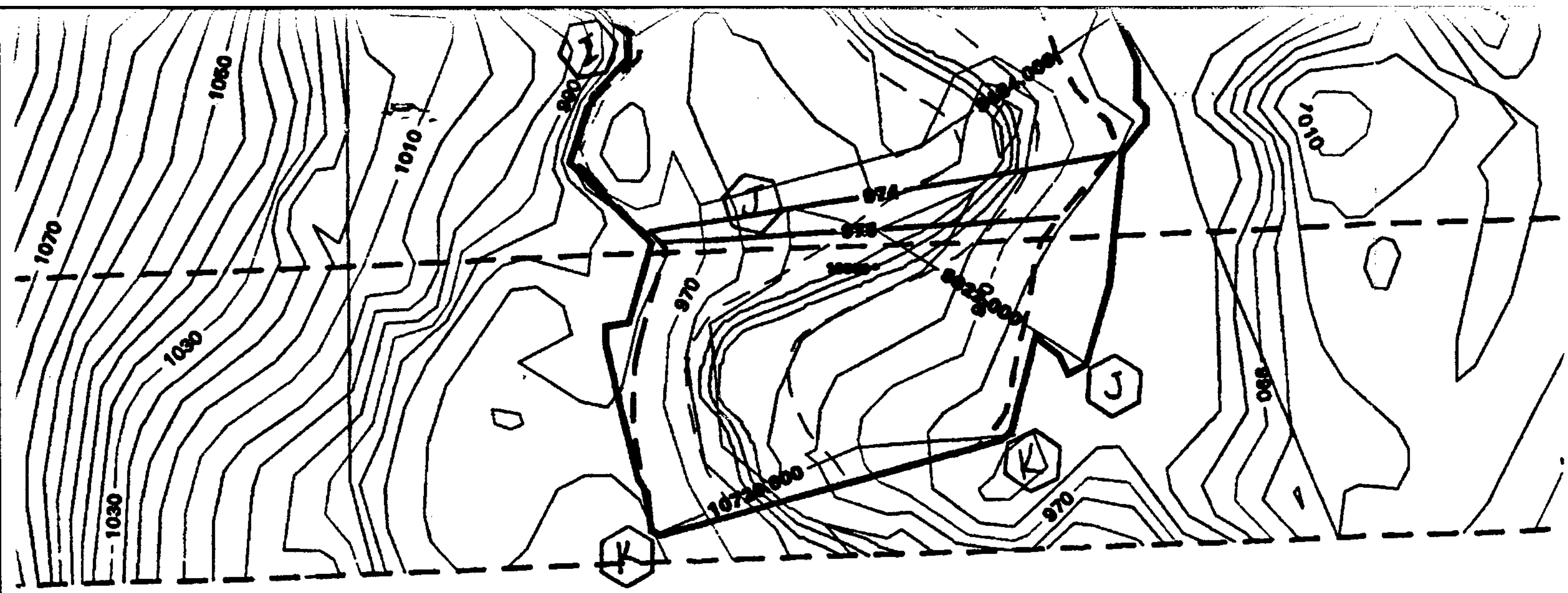
TONAWANDA CREEK



JDY

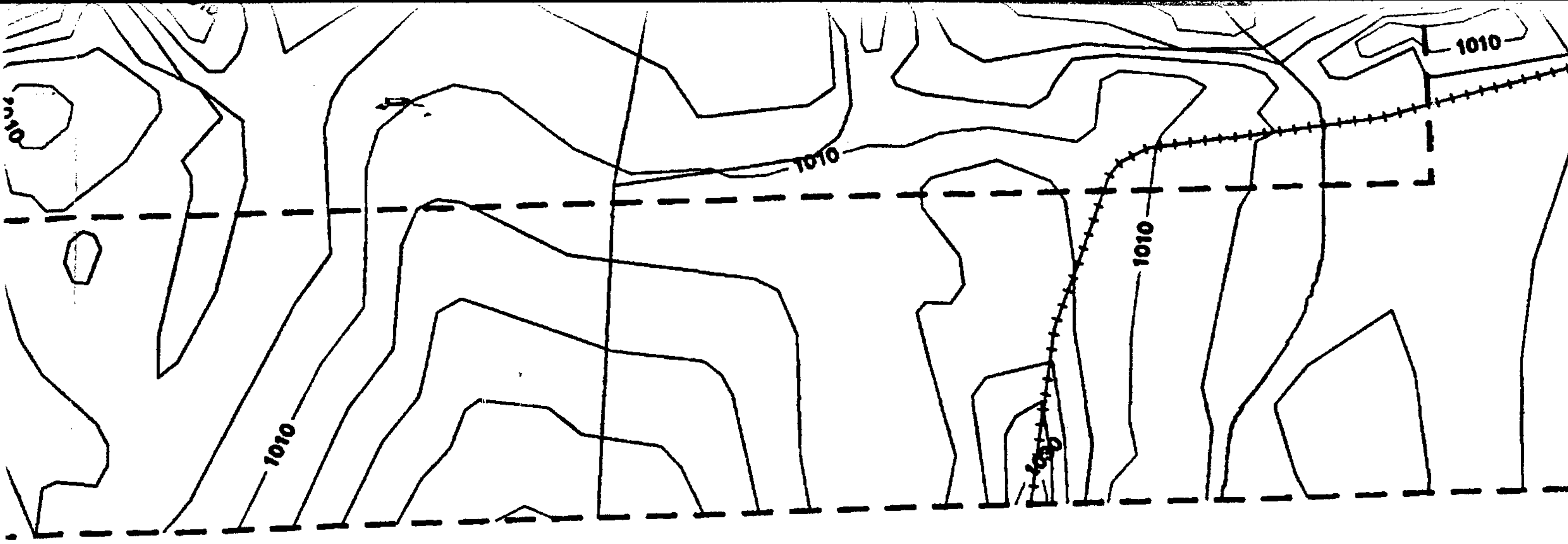
Base Mappi

US



e Mapping: USGS DIGITAL DATA SETS

US ARMY CORPS OF ENGINEERS
BUFFALO DISTRICT



ERS

Scale 1" = 400'

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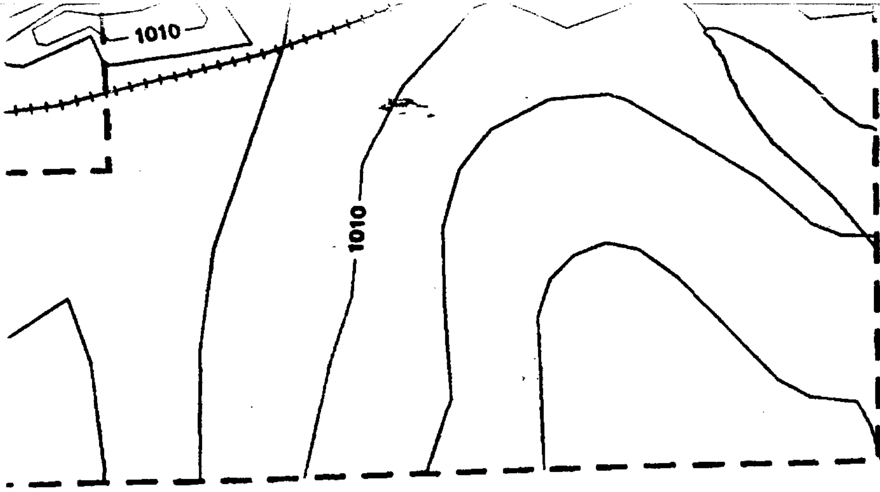
Vert. Datum: NGVD 1929



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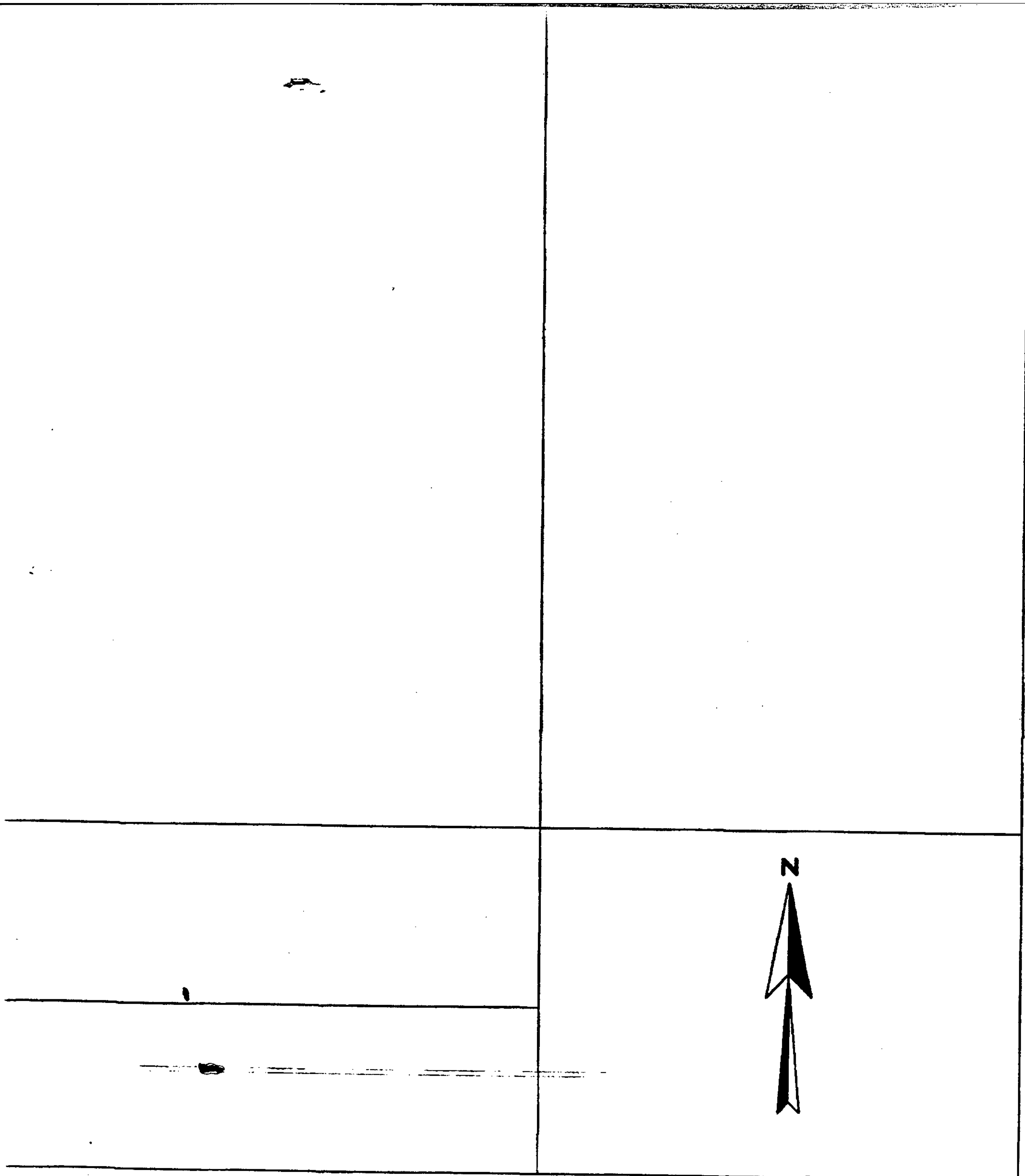
D83 /D 1929	Date: April 04, 2000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